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Growth Through Agricultural Progress



# COTTON FIBER and SPINNING PROPERTIES

## as affected by certain ginning practices in San Joaquin Valley, California, Season 1958-59

Marketing Research Report No. 486

U.S. Department of Agriculture- Economic Research Service

Marketing Economics Division

## OTHER RECENT DEPARTMENT PUBLICATIONS ON QUALITY EVALUATION OF COTTON:

Marketing Research Report No. 238, "Effects of Lint Cleaning of Cotton," May 1958.

Marketing Research Report No. 269, "Effects of Cleaning Practices at Gins on Fiber Properties and Mill Performance of Cotton," August 1958.

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## CONTENTS



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## SUMMARY

This study of the effect of certain gin cleaning and drying practices on fiber properties and spinning performance of cotton was conducted cooperatively with the U. S. cotton field station at Shafter, Calif., and a commerical ginning company, using cotton from the 1958 crop. The work was done in a new 1,008-spindle pilot spinning plant.

Ginning conditions in this study consisted of normal drying with and without the use of two stages of lint cleaning; extra drying with two lint cleaners; and no drying (no heat applied) with two lint cleaners. Cotton was put through unit-type, pneumatic lint cleaners, then through a bulk saw-type lint cleaner. Overhead seed cotton cleaning equipment remained constant throughout the study.

Incoming seed cotton contained minimum amounts of foreign matter and moisture and was in excellent condition for ginning. Lint moisture before drying ranged from 5.9 to 6.4 percent. At time of ginning temperature was 95° F. at 26 percent relative humidity.

Middling Plus grades of cotton were obtained when lint cleaners were used, regardless of the amount of drying. Nonlint content of the Middling cotton produced by normal drying with no lint cleaning was 5.5 to 7 pounds more than that of the Middling Plus cotton. With a premium of 35 points per pound for the higher grade, a producer would lose 3 to 51 cents a bale because of the weight removed. When extra drying was used, weight loss resulting from moisture removal caused an additional loss of $1.10 per bale. Ginning charges for lint cleaning would increase this loss by an additional $1.60 per bale.

Although the Middling cotton had a significantly higher nonlint content than other grades obtained, there was no difference in any of the cottons after they had been subjected to mill cleaning and carding.

Normal or extra drying, lint cleaning, nor any combination of these treatments had any significant effect on standard fiber property measurements. Although upper half mean length and uniformity ratio as measured by the Fibrograph were not affected, mean length showed some adverse effects. Mean length as measured on the Suter-Webb array was not affected. The adverse effects of normal and extra drying on the pattern of length distribution were highly significant. Lint cleaning had no tendency to increase variability under normal drying conditions. The proportion of fibers shorter than one-half inch was significantly lower for cotton which had been subjected to lint cleaning and no drying, as compared with normal and extra drying, with or without lint cleaning.

Of special significance in this study was the normal use of drying to achieve a desirable and normal moisture level in the ginned lint, as compared with the use of ambient temperature and its effect on drying and on short fiber content. The application of 230° F. at the inlet of one drier (180° F. at outlet) produced lint with a moisture content of 3.4 percent, but the use of ambient temperature (95° F., 26 percent relative humidity) on slightly damper cotton produced lint with a 3.8 percent moisture content. This illustrates the highly significant drying effect which is achieved by the use of large air volumes with low relative humidity at high natural temperature. Even though a low level of lint moisture was obtained without the use of driers, the short fiber content for normally dried cotton was significantly higher than for cotton subjected to ambient temperature.

The use of lint cleaners reduced the opening, picking, and card waste at mills, regardless of the level of drying. However, after carding, all cottons contained the same amount of visible foreign matter, regardless of treatment.

Extra drying, in combination with lint cleaning, produced yarn with a break factor considerably below that for the other conditions studied. Under the normal drying conditions, the use of lint cleaners produced yarn which was significantly lower in strength than nonlint cleaned cotton. There was no significant difference in the break factor of cotton which had been subjected to no drying and lint cleaning compared with cotton which had received normal drying and no lint cleaning.

Ends-down in spinning was increased significantly by extra drying and lint cleaning compared with normal drying and no drying, both in combination with lint cleaning. Normal drying and no drying, both in combination with lint cleaning, had essentially similar effects on ends-down.

The percentage of moisture removed from lint cotton by drying and the percentage of fibers shorter than one-half inch explained 48 percent of the variation in ends-down. However, moisture removal only, after eliminating the effect of short fibers, was significant for its effect on ends-down. Thus, increasing the proportion of moisture removed causes a corresponding change in short fiber content and this change exerts a significant effect on ends-down in spinning.

Because of the narrow range of moisture studied in this test, the effect of drying on fiber and spinning performance was small. If the moisture conditions noted at time of harvest are typical for this California area when the great bulk of the crop is processed, drying is not generally needed. If the range of moisture is considerably higher, heat in increasing amounts only increases the proportion of lint moisture removed. Under these conditions, the range in moisture removed would be much wider, short fibers might be expected to increase, and differences in spinning performance, as measured by ends-down per thousand spindle hours, would tend to widen. Therefore, not only is final lint moisture level important for its effect on fiber and spinning performance, but equally important are the range of moisture involved and the means used in reducing the amount of moisture present.

# COTTON FIBER AND SPINNING PROPERTIES AS AFFECTED BY CERTAIN GINNING PRACTICES IN THE SAN JOAQUIN VALLEY, CALIFORNIA IN THE SEASON 1958-59

By John E. Ross, Clarence G. Leonard, and
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## INTRODUCTION

The San Joaquin Valley of California has become one of the major cotton producing areas in the United States. Its growth has been accompanied by a rapid increase in mechanization. Formerly, most of the cotton was picked by hand early in the season, and the remainder of the crop was picked by machine. This procedure usually extended the harvesting and ginning season well into December or even later. More than 80 percent of the San Joaquin Valley crop is now picked by machine and many producers pick their entire crop this way. The timing of the harvest has thus been changed. Because there is usually no change in weather conditions in this area until November, cotton is left in the field until a substantial proportion of the bolls are fully opened. The great bulk of the crop is now picked in October and November when the weather is usually good.

Cotton gins have introduced new cleaning devices to handle rougher machine-harvested cotton. Often extra drying equipment has been added, or existing facilities enlarged by increasing the burner capacity of the heaters.

Because of relatively favorable weather conditions in California, mechanically harvested cotton in that State, especially when defoliation has reduced the amount of green leaf present at the time of harvesting, generally reaches the gin as dry as or drier than is generally recommended for ginning. Further reduction of lint moisture by artificial drying to facilitate cleaning may cause damage to the inherent fiber and spinning qualities of the ginned lint.

In the past several years, textile mills have indicated that repeated application of gin drying and cleaning equipment and its misuse in striving for higher grade levels have seriously impaired cotton's spinnability. Even though grade levels might have been improved with no noticeable effect on standard fiber property measurements, very significant changes in cotton's spinnability may occur. In turn, this reduction in spinnability has resulted in increased processing costs and lower value of the finished products. And in general, the economic position of American cotton, both at home and abroad, has been adversely affected.

Thus, alleviation of a major economic problem in the marketing of cotton depends on the identification and measurement of those attributes which constitute cotton quality. Proper values must be placed on these attributes to assure equitable pricing. Therefore, scientific and technological problems are involved in identification and measurement of these quality attributes, and the complete solution involves engineers, technologists, economists, physicists, chemists, and others.

The study, involving cotton from the 1958 crop, is the first in a group of broad

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studies conducted cooperatively by the U. S. Department of Agriculture and a commercial ginning company. The object was to determine the effects of drying and lint cleaning on fiber properties, grade, and spinning performance of cotton grown in the San Joaquin Valley of California.

## TEST PROCEDURES

### Harvesting

The cotton in this test was picked mechanically by two one-row, high-drum machines operated by personnel of the U. S. cotton field station at Shafter under direct supervision of agricultural engineers engaged in the research. The test cotton, Acala 4-42, was harvested in mid-October after nearly all the bolls were open. The 8-acre field had a yield history of slightly better than two bales an acre. The entire field received identical treatment with regard to cultivation, irrigation, fertilization, and defoliation.

Picking was started in midmorning after the relative humidity had reached a stable level. Weather conditions were identical for all lots throughout the harvesting and ginning period.

The two pickers were of the flush type of spindle bushing lubrication. They were flush lubricated at the end of each picking period with 2 gallons of lightweight oil (designated as CP-9) as recommended by the picker manufacturer. 2/ After being lubricated, these pickers were not used until the next morning when the second half of the cotton was harvested.

A spindle moistening agent, Ortho Spindlewet, 2/ was mixed with water at the rate of 1/2 pint to 30 gallons of water. The flow of this mixture was adjusted for the minimum that could be used and still keep the picker spindles clean.

### Ginning

In the design of the test, overhead seed cotton cleaning was a constant factor in all four ginning conditions. Drying consisted of three levels: (1) That considered "normal" for the particular time of year, (2) "extra" drying which reduced the lint moisture level below 3 percent, and (3) "no drying" (no artificial heat added). It was recognized that all drying conditions might reduce the moisture content of lint below the level recommended for satisfactory ginning and preservation of inherent spinning qualities. Cleaning conditions were as follows: (1) No lint cleaning, and (2) lint cleaning by unit-type, pneumatic lint cleaners and a saw-type lint cleaner in tandem. With these ginning processes, four separate comparisons were made where one variable could be measured: (1) Normal drying with no lint cleaning versus normal drying and lint cleaning, (2) normal drying and lint cleaning versus extra drying and lint cleaning, (3) extra drying and lint cleaning versus no drying and lint cleaning, and (4) normal drying and lint cleaning versus no drying and lint cleaning.

The ginning treatments used in this test are shown in table 1. Drying conditions were obtained by adjusting the drier outlet air temperatures on the two driers. Although it is preferable to control the drier inlet air termperatures, it was not possible with the off-on or maximum-minimum type controller on these driers.

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2/ Use of manufacturers' brand names does not imply Department approval of the product used over similar products distributed by other manufacturers.

Table 1.--Treatments of seed cotton and lint at gins in ginning-spinning tests, Shafter, Calif., season 1958-59

| Ginning treatments | Drying air temperatures 1/ | | Seed cotton cleaning and extracting equipment | Lint cleaning equipment |
|---|---|---|---|---|
| | 1st drier °F | 2nd drier °F | | |
| 1. Normal drying, no lint cleaning | 180 | Ambient | 19 cylinders, bur machine and extractor feeders | None |
| 2. Normal drying, two lint cleanings | 180 | Ambient | " | Two lint cleaners--a unit pneumatic type and a bulk saw type in tandem |
| 3. Extra drying, two lint cleanings | 200 | 200 | " | " |
| 4. No drying, two lint cleanings | Ambient | Ambient | " | " |

1/ The driers were equipped with on-off or maximum-minimum type temperature controllers and had fluctuations in inlet temperatures; therefore, the temperatures listed are for the drier outlet that remains stable.

Controls of this type were generally in use at commercial gins at the time of this test. This type of control normally causes the inlet air temperature to fluctuate through a wide range as the burner cycles from maximum to minimum. However, the outlet air temperature remains relatively stable at the chosen value because of the large thermal inertia of the drier and because the regulating control for the drier is set at a given point.

A detailed outline of the ginning equipment used is shown in figure 1. A multi-channel recording thermometer was installed for the tests; one thermometer was placed in the inlet and one in the outlet of each drier. Continuous readings were obtained throughout the ginning of each lot.

The gin room air temperature and relative humidity were recorded on a portable hygrothermograph located about 6 feet above the floor near the gin stands.

For the two normal drying conditions, with and without lint cleaning, drier outlet temperatures on the first drier were maintained at a level of about 182° F. with an inlet temperature of about 230° (table 2). No heat was applied to the second drier but temperatures inside these driers were higher than atmospheric conditions outside because of the transfer of heat from the cotton to the air which was used to move the cotton through the second drying stage and because of the small rise in temperature across the fan. The temperature of the air on the outlet side of a fan is several degrees higher than that of the air entering the fan. This difference is caused by the compression of the air by the fan.

To achieve extra drying, temperatures at both drier outlets were maintained at 201° F. with inlet temperatures of 260-270° F.

When no drying was used the burners were turned off; but some drying was obtained because the inlet and outlet temperatures were higher than atmospheric conditions. This higher temperature was caused by the long period of time needed to cool the machinery, by friction, and by the rise in temperature caused by the fans.

## Sampling

Each lot of incoming seed cotton was sampled to determine seed cotton moisture content, foreign matter content, and lint moisture content. The amount of moisture initially present in the lint was obtained by roller ginning seed cotton on a laboratory size roller gin. Subsequent oven lint moisture tests provided an accurate basis for determining the amount of moisture removed by drying.

Samples of seed cotton were taken from the feeder apron just ahead of the gin stand to determine the amount of foreign matter and moisture remaining after cleaning and drying. Samples of lint were taken from the lint slide to determine their moisture content after processing.

## Fiber and Spinning Tests

Procedures employed by the Fiber Laboratory follow those promulgated for service testing by the Department of Agriculture. 3/ For any bale comprising one replication for a given ginning condition, the number of observations per bale ranged from 8 for micronaire, 12 for Suter-Webb arrays, and 16 for Fibrograph, to 24 for

3/ Cotton Division Instructions No. 918-8. U. S. Dept. Agr., Agr. Mktg. Serv. Dec. 1958.

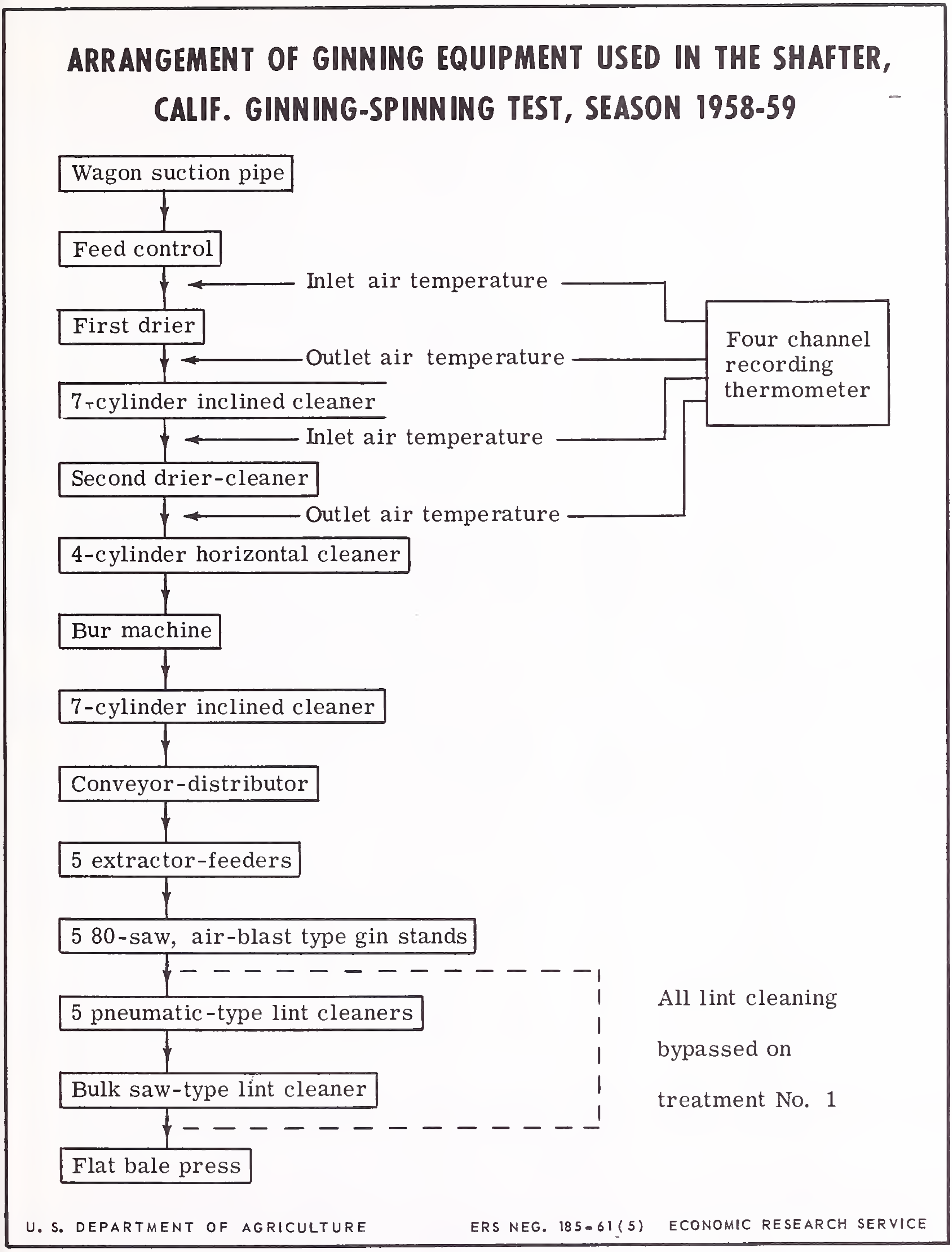
ARRANGEMENT OF GINNING EQUIPMENT USED IN THE SHAFTER, CALIF. GINNING-SPINNING TEST, SEASON 1958-59
Wagon suction pipe
Feed control
Inlet air temperature
First drier
Outlet air temperature
Four channel recording thermometer
7-cylinder inclined cleaner
Inlet air temperature
Second drier-cleaner
Outlet air temperature
4-cylinder horizontal cleaner
Bur machine
7-cylinder inclined cleaner
Conveyor-distributor
5 extractor-feeders
5 80-saw, air-blast type gin stands
5 pneumatic-type lint cleaners
All lint cleaning bypassed on treatment No. 1
Bulk saw-type lint cleaner
Flat bale press
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Figure 1

Table 2.--Temperature of drying air and temperature of relative humidity of gin room for cotton treatment, ginning spinning test, Shafter, Calif., season 1958-59

| Item | | Ginning treatment | | | |
|---|---|---|---|---|---|
| | | 1<br>Normal drying, no lint cleaning | 2<br>Normal drying, two lint cleanings | 3<br>Extra drying, two lint cleanings | 4<br>No drying, two lint cleanings |
| Drying air temperatures: | | | | | |
| 1st drier, average inlet 1/ | ° F. | 229 | 232 | 261 | 107 |
| 1st drier, outlet | ° F. | 183 | 182 | 201 | 111 |
| 2nd drier, average inlet 1/ | ° F. | 111 | 113 | 271 | 110 |
| 2nd drier, outlet | ° F. | 116 | 122 | 202 | 116 |
| Gin room atmosphere: | | | | | |
| Temperature | ° F. | 95 | 96 | 94 | 96 |
| Relative humidity | percent | 26 | 26 | 26 | 26 |

1/ Inlet air temperatures varied from 30 to 60° F. due to the on-off type of heat controller used.

Pressley strength. For a given ginning condition having four one-bale replications, four times as many tests were made as are listed above.

In processing these cottons, the ties were broken on four bales (one from each ginning treatment) 24 hours before they were to be processed through the opening and picking equipment. This allowed the compressed cottons to bloom and condition before processing.

In the card room and in the spinning room, each bale was processed on an individual bale basis under controlled conditions of 75° F. and 55 percent relative humidity.

The cotton from each bale was fed into two blender feeders; the feeders delivered it onto a conveyor belt. This belt fed the cotton to the lattice opener. This machine removes a small amount of trash and waste, but its main purpose is to open the cotton and get it in condition for the picker.

From the lattice opener the cotton was delivered to a blender reserve box and then fed to a one-process picker, where a 14-ounce lap, 46 yards long, was produced. During the picker operation, the cotton was fed to a three-blade beater, which delivered 60 blows per inch to the cotton. It then went to a Kirschner beater where it received 43 blows per inch.

In the carding operation four standard cotton cards were used. The laps produced from each lot were carded into a 50-grain sliver at 9 1/2 pounds per hour. The predetermined weight of the laps produced a carding cycle of 4 hours. During this cycle three nep boards were taken from each card at the 3/4, 1/2 and 1/4 position of the lap, from which an independent nep count was made by two technicians.

After each lap had been carded the flats were run out, and the cards stripped and thoroughly cleaned. A record of waste from flat strips, cylinder and doffer strips, and motes and fly was obtained on each lap.

The card sliver then entered two processes of drawing. The card sliver was fed to the first process of drawing, 8 ends up, and processed into a 53-grain drawing sliver. This sliver was fed back through the drawing, 8 ends up, and made into a 55-grain finished drawing sliver. At the second process of drawing, the sliver was delivered into 84 cans containing equal yardage so that it could be creeled into the slubber. At the slubber, the 55-grain sliver was made into a 1.25 hank roving using 1.30 twist multiplier and a spindle speed of 900 r. p. m.

Twelve doffs of equal yardage of 1.25 hank roving were delivered to the spinning room, and each doff was equally distributed to the four spinning frames. Each frame had 252 spindles to spin 40's yarn from single creeled 1.25 hank roving. All yarn was spun with a front roll speed of 148 r. p. m., 3.75 twist multiplier, 11,000 r. p. m. spindle speed, and a 6/0 traveler.

Before spinning each lot, new travelers were placed on the rings, and the frames were run for 30 minutes before ends-down counts were begun. This period served as a break-in period for the travelers, and also produced yarn for sizing.

A spinning test on each lot consisted of running a full doff of 40's yarn, which required 8 1/2 hours of continuous frame operation, and yielded 8,568 spindle hours. Ends-down were recorded hourly on 15 minute cycles.

## Processing

| | |
|---|---|
| Opening equipment used - - - - - - - - | (2 blender feeders<br>(1 lattice opener |
| Picker - - - - - - - - - - - - - - - - - | Two-section, one-process picker |
| Carding - - - - - - - - - - - - - - - - | 4 standard cards |
| Drawing - - - - - - - - - - - - - - - - | Two process |
| Roving - - - - - - - - - - - - - - - - - | 1 slubber 10 x 5, 84 spindles |
| Spinning - - - - - - - - - - - - - - - - | Single creel roving - spun on<br>Duo-Roth system of drafting |

See Appendix A for complete details on processing, organization, and machinery settings.

## ANALYSIS OF RESULTS

### Condition of Seed Cotton

The foreign matter content of seed cotton as it arrived at the gin was fairly uniform; it was near the minimum level for mechanically picked cotton (table 3). The cotton was dry, which is normal in this California area in mid-October. The moisture content of the lint on the trailer ranged from 5.9 to 6.4 percent and was considered to be in excellent condition for ginning with no drying.

The proportion of moisture removed (about 41 percent) was about the same for normal drying on one drier using 183° F. with lint cleaning, as it was for no drying with lint cleaning. This illustrates the important effect which moving seed cotton in ambient air at relatively low humidity and high temperature has on the moisture content of the ginned lint. Since cotton is hygroscopic, it tends to come to moisture equilibrium with the air to which it is exposed. During the test, the average gin room air temperature was 95° F. with a relative humidity of 26 percent. When this ambient air temperature was raised to an average of 113° F. by friction and temperature rise across the fan, it had a relative humidity of approximately 15 percent. The equilibrium moisture content of lint cotton in 15 percent relative humidity air is approximately 3 percent; therefore, drying began as soon as the cotton entered the air stream. Generally, only the moisture in the lint forming a part of the seed cotton was affected by this drying action.

When normal drying was combined with lint cleaners, 42 percent of the lint moisture was removed. This slight increase in the proportion removed may be due to the action of lint cleaners in removing foreign matter which usually contains substantial amounts of moisture. When two driers were used with outlet temperatures of about 200° F., lint moisture was reduced to 2.7 percent, and 58 percent of the original moisture was removed.

The amount of foreign matter remaining in seed cotton after cleaning was not significantly different in the four treatments studied. Although seed cotton which had received no drying contained slightly more foreign matter as the cotton entered the gin stand, the subsequent lint cleaning produced cotton of grades identical with those of cotton which had been both normally and excessively dried.

Table 3.--Foreign matter and moisture content of seed cotton and lint before and after specified drying and cleaning treatments, Shafter, Calif., season 1958-59

| Item | Ginning treatments | | | | Least significant difference | |
|---|---|---|---|---|---|---|
| | 1 Normal drying, no lint cleaning | 2 Normal drying, two lint cleanings | 3 Extra drying, two lint cleanings | 4 No drying two lint cleanings | 5% level | 1% level |
| | Percent | Percent | Percent | Percent | | |
| Foreign matter; seed cotton | | | | | | |
| Wagon | 6.0 | 6.2 | 6.7 | 7.0 | 1/N.S. | N.S. |
| Feeder | 1.5 | 1.6 | 1.4 | 2.2 | N.S. | N.S. |
| Moisture; seed cotton | | | | | | |
| Wagon | 6.8 | 6.8 | 6.8 | 7.3 | N.S. | N.S. |
| Feeder | 5.0 | 5.0 | 4.8 | 5.4 | N.S. | N.S. |
| Moisture; lint | | | | | | |
| In trailer (dry basis) | 5.9 | 5.9 | 6.4 | 6.4 | N.S. | N.S. |
| On lint slide (dry basis) | 3.6 | 3.4 | 2.7 | 3.8 | .4 | .6 |
| Proportion of moisture removed | 39 | 42 | 58 | 41 | - | - |

1/ Not statistically significant.

## Grade, Staple, Neps, and Nonlint Content

Grades for cotton ginned with lint cleaners, regardless of the drying condition employed (table 4), differed little. Normal drying without lint cleaning produced a grade equivalent to Middling, or about 1/2 grade lower than when lint cleaners were used. Nonlint content of the ginned Middling cotton was 15.5 pounds a bale compared with 8 1/2 - 10 pounds for Middling Plus cotton.

With a premium of 35 points a pound for Middling Plus, a producer would gain from lint cleaning in cents a pound, but in terms of weight loss, he would lose 3 to 51 cents a bale. 4/ If extra drying were used and if no grade improvement were achieved, an additional loss of $1.10 a bale would occur through loss of weight by moisture removal. In addition, there is some indication that staple length might be adversely affected by these combined practices. If producers paid the prevailing rate of 10 cents a hundredweight of seed cotton for lint cleaning, net loss would be further increased by about $1.60 a bale. 5/

After cottons of both grades were subjected to mill opening, cleaning, and carding machinery there was no difference in the nonlint content. Therefore, the cost of the clean lint to the mill would be 3 to 51 cents per bale lower for the lint cleaned at the gin than for that not cleaned at the gin.

There was a tendency, both in the ginned lint and in the card web, for neps to be more prevalent when lint cleaners were used. However, the level of neps in all lots was extremely low, and differences among the four ginning conditions were not statistically significant.

## Fiber Properties

The use of normal or extra drying, lint cleaning, or a combination of any of these practices produced few significant effects on standard fiber property measurements (table 5). Upper half mean length and uniformity ratio as measured by the Fibrograph showed no significant adverse effects from lint cleaning alone, although drying in combination with lint cleaners tended to affect these elements of length. Mean length as measured by the Fibrograph was significantly reduced by both normal and extra drying in combination with lint cleaning. However, when the mean length was measured by the Suter-Webb sorter, there was no significant effect of the use of any of the drying or cleaning practices. This same relationship was also found for upper quartile length.

The coefficient of length variability was significantly and adversely affected by the use of both normal drying and extra drying. Lint cleaning showed no tendency to increase variability under normal drying conditions and did not affect short fiber content significantly. The proportion of fibers shorter than one-half inch was significantly lower for cotton which had had no drying and lint cleaning as compared with cotton which had normal and extra drying, with or without lint cleaning.

The grade level achieved by using lint cleaners in combination with normal drying, extra drying, or no drying was about the same, being the equivalent in value of Middling

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4/ Based on Middling 1-1/16 with price of 32 cents per pound, Fresno, Calif., market.

5/ James S. St. Clair and Arthur L. Roberts. Effects of Lint Cleaning of Cotton. An Economic Analysis at California Gins. U. S. Dept. Agr., Agr. Mktg. Serv., Mktg. Rpt. No. 238, May 1958.

Table 4.--Grades of cotton from similar lots subjected to different ginning treatments, in tests at Shafter, Calif., 1958-59 1/

| Ginning treatments | Replications | | | | Average index 2/ |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| 1. Normal drying, no lint cleaning | M | M | M | M | 100 |
| 2. Normal drying, two lint cleanings | SM | M | M | SM | 102 |
| 3. Extra drying, two lint cleanings | SM | SM | M | M | 102 |
| 4. No drying, two lint cleanings | SM | M+ | M | M | 101 |

1/ Staple length designations for all replications were 1-1/16 inches.
2/ 100 = Middling (M), 101 = Middling + (M+), 104 = Strict Middling (SM).

Table 5.--Effects of gin drying and lint cleaning practices on certain fiber properties, Shafter, Calif., ginning-spinning test, season 1958-59

| Fiber properties | Unit | Ginning treatments 1 Normal drying, no lint cleaning | 2 Normal drying, two lint cleanings | 3 Extra drying, two lint cleanings | 4 No drying two lint cleanings | Least significant difference 5% level | 1% level |
|---|---|---|---|---|---|---|---|
| Fibrograph: | | | | | | | |
| Upper half mean | Inches | 1.06 | 1.04 | 1.04 | 1.06 | N.S.1/ | N.S. |
| Mean length | Inches | .90 | .88 | .88 | .89 | .014 | N.S. |
| Uniformity ratio | Percent | 85 | 84 | 84 | 84 | N.S. | N.S. |
| Strength: | | | | | | | |
| 0 gauge | 1,000 p.s.i. | 94 | 94 | 94 | 95 | N.S. | N.S. |
| 1/8" gauge | Index | 120 | 119 | 116 | 119 | N.S. | N.S. |
| Micronaire, fineness: | | 4.6 | 4.6 | 4.6 | 4.6 | N.S. | N.S. |
| Causticaire: | | | | | | | |
| Fineness | M/inch | 4.6 | 4.6 | 4.7 | 4.6 | N.S. | N.S. |
| Maturity | Index | 80 | 80 | 79 | 79 | N.S. | N.S. |
| Suter-Webb Sorter: | | | | | | | |
| Upper quartile length | Inches | 1.19 | 1.18 | 1.18 | 1.19 | N.S. | N.S. |
| Mean length | Inches | 1.00 | 1.00 | .99 | 1.01 | N.S. | N.S. |
| Coefficient of variability | Percent | 27.8 | 27.8 | 28.2 | 26.5 | .8 | 1.1 |
| Fibers shorter than ½" | Percent | 7.5 | 7.6 | 8.1 | 7.1 | .4 | .6 |
| Nonlint content: | | | | | | | |
| Ginned lint | Percent | 3.1 | 1.7 | 1.7 | 2.0 | .4 | .6 |
| Card sliver | Percent | .16 | .16 | .20 | .14 | N.S. | N.S. |

1/ Not statistically significant.

or better. This was about one-half grade higher than the grade values obtained by the use of normal drying practices and no lint cleaning. Therefore, for machine-picked cotton which arrives at the gin dry and containing little foreign matter, drying serves little useful purpose as an aid to cleaning and grade improvement. In this particular test, it was not possible to measure the effect that overhead seed cotton cleaning machinery had on the formation of fiber shorter than one-half inch.

Of special significance in this study is the relative effect of ambient temperature and normal drying on short fiber content. The application of 230° F. at the inlet of one drier (180° F. at outlet) produced lint with a moisture content of 3.4 percent, but the use of ambient temperature on slightly damper cotton produced lint having 3.8 percent moisture content. This illustrates the highly significant drying effect achieved by the use of large air volumes with a low relative humidity level of 25 percent at a temperature of approximately 95° F. Even though a low level of lint moisture was obtained without heat and it compared favorably with the level produced by using heat, the short fiber content for normally dried cotton was significantly higher than in cotton dried by ambient air.

## Spinning Performance

The use of lint cleaners significantly reduced opening, picking, and card wastes (table 6), regardless of the extent of drying in combination with these cleaners. Specifically, nearly the same amount of waste was removed by mill-cleaning practices from cotton which had received no drying in combination with lint cleaning, as was removed by either normal or extra drying in combination with these cleaning devices. Grades of lint ginned under these combinations were about the same. So, for cotton harvested at such moisture levels, drying serves little useful purpose insofar as grade improvement is concerned and may adversely affect spinning quality.

Extra drying in combination with lint cleaning produced yarn with a break factor considerably lower than the other conditions studied. Under normal drying conditions, lint cleaning produced yarn which was significantly lower in strength than the cotton not subjected to lint cleaning. There was no significant difference in the strength of cotton which had received no drying and lint cleaning compared with cotton which had received normal drying and no lint cleaning.

Yarn appearance grade was identical for all four ginning conditions at C+ or average.

Yarn evenness and yarn variability as determined by the Uster test did not differ significantly among the four ginning treatments. Imperfections in yarn as determined by the Brush method also showed little differences, but lint cleaning, used in combination with normal or extra drying practices, produced less uniform yarns. Drying in any combination with lint cleaning had no significant effect on the formation of neps during carding. However, the level of neps for all conditions was below normal.

## Ends-Down in Spinning

An important measure of the processing performance of cotton is its ability to be processed with a minimum of ends-down in spinning. A break in the yarn in manufacturing, commonly called an end-break or ends-down, must be repaired by hand labor. Work assignments per spinner are based on the number of spinning frames a spinner can tend and keep yarn breaks to a minimum. If cotton does not

Table 6.--Effect of gin drying and lint cleaning practices on certain spinning properties and processing characteristics, Shafter, Calif., ginning-spinning test, season 1958-59

| Processing data | Unit | Ginning treatments: 1 Normal drying, no lint cleaning | 2 Normal drying, two lint cleanings | 3 Extra drying, two lint cleanings | 4 No drying, two lint cleanings | Least significant difference: 5% level | 1% level |
|---|---|---|---|---|---|---|---|
| Waste: | | | | | | | |
| Opening and picking | Percent | 1.32 | .37 | .40 | .39 | .09 | .13 |
| Carding | Percent | 4.90 | 4.50 | 4.37 | 4.40 | .22 | .32 |
| Total mfg. waste | Percent | 6.22 | 4.87 | 4.77 | 4.79 | - | - |
| Yarn: | | | | | | | |
| Break factor | Index | 2496 | 2430 | 2316 | 2456 | 56 | 80 |
| Appearance grade | Index | C+ | C+ | C+ | C+ | - | - |
| Size | | 39.92 | 39.60 | 40.50 | 39.75 | - | - |
| Unevenness 1/ | Percent | 18 | 18 | 19 | 18 | N.S. 2/ | N.S. |
| Coefficient of variability 1/ | Percent | 21 | 22 | 22 | 22 | N.S. | N.S. |
| Nonuniformity 3/ | Percent | 111 | 117 | 117 | 113 | 2.8 | 4.2 |
| Yarn imperfection 4/ | Number | 331 | 361 | 318 | 309 | N.S. | N.S. |
| Ends-down/M/S/H | Number | 31 | 30 | 42 | 31 | N.A. 5/ | N.A. |
| Neps/100 sq. in. card web | Number | 6 | 11 | 10 | 10 | N.S. | N.S. |
| Neps, ginned lint 6/ | Number | 8 | 10 | 10 | 10 | N.S. | N.S. |

1/ As determined by the Uster test.
2/ Not statistically significant.
3/ As determined by the Brush method. Brush uniformity analyses set on 10 ft. sensitivity length. The instrument was not calibrated with a standard: therefore, the results are only relative.
4/ Brush imperfection counter sensitivity set on 480. Imperfection in 500 yd. of cotton.
5/ Analysis not applicable - See table 7.
6/ Neps as measured by Nepotometer (readings comparable to those obtained on 100 sq. in. of card web).

spin well, the work loads must be decreased and more spinning labor must be employed. Therefore, direct labor costs in spinning can be affected by a change in the spinning properties of cotton.

In this particular test, ends-down per thousand spindle hours for extra dried cotton (treatment 3) averaged 10.3 EDMSH 6/ more than for cotton which had not been dried at ambient temperatures (treatment 4, table 7). In practical terms this difference between these two ginning conditions consists of a highly significant increase of 32 percent in ends-down. Because a difference of 10 EDMSH or more can be expected less than once in 10,000 times from possible errors in sampling, this difference probably represents a real difference and must be due to the extra drying. Based on the variability of this particular test it can be expected that this difference in EDMSH due to the drying treatments can range from about 9 to 17.

A comparison of the processing performance of extra dried cotton with normally dried cotton indicates that one can expect a similar difference in ends-down. Therefore, the use of driers to reduce lint moisture below 3 percent, as compared with no drying and normal drying, contributes materially to decreased processing performance.

Statistically there was only a slight difference in EDMSH under normal drying conditions when lint cleaners were used as compared with not using them. This same relationship held true when normal drying with lint cleaners was compared with no drying and lint cleaners. Specifically, in about half the cases, one could expect a similar difference in ends-down to occur as the result of sampling variation. In practical terms, this does not indicate a significant difference between these ginning treatments as measured by ends-down in spinning.

## Relation of Fibers Shorter than One-half Inch and Moisture Removal to Spinning Performance

Multiple correlation analysis using proportion of lint moisture removed and fibers shorter than 1/2 inch indicates that 48 percent of the variation in ends-down in spinning was attributable to these two factors. Further analysis shows that only the proportion of lint moisture removed was significant for its effect on ends-down. Partial regression coefficients were .18 for fibers shorter than 1/2 inch and .58 for moisture removal. These coefficients indicate that short fiber content alone is not a significant factor, but the change in short fiber content due to moisture removal becomes significant for its effect on ends-down in spinning.

Within the narrow range of moisture studied in this test, the effect of drying on fiber and spinning performance was small. However, if the moisture conditions at time of harvest are typical of those for the area when the great bulk of the cotton is processed, heat is not generally needed. If the range of moisture present is considerably higher that experienced in this study, the use of elaborate drying systems only increases the proportion of moisture removed. Therefore, the range would be widened, and the short fiber content might increase and cause wider differences in ends-down per thousand spindle hours. 7/ In addition, it is reasonable to assume that not only is final natural lint moisture level important for its effect on fiber properties and spinning performance, but equally important are the range of moisture and the means used to remove moisture. The data suggest that if an identical lint moisture is achieved from two cottons having different original moisture levels, short fibers and ends-down might

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6/ Ends-down per thousand spindle hours.

7/ U. S. Dept. Agr., 1958. Effects of Cleaning Practices on Fiber Properties and Mill Performance of Cotton. Mktg. Res. Rpt. No. 269 - A Progress Rpt. - 20 p.

Table 7.--Mean differences in ends-down/thousand spindle hours, P values, and confidence intervals between specified ginning treatments, ginning-spinning test, Shafter, Calif., season 1958-59 1/

| Item | Deviations between ginning treatments 1/ | | | |
|---|---|---|---|---|
| | 2 from 1 | 2 from 3 | 4 from 3 | 2 from 4 |
| Mean difference, EDMSH 2/ | 1.38 | 11.65 | 10.3 | 1.35 |
| P value | .5 | .0001 | .0001 | .6 |
| Confidence interval 3/ | -2.9 to 5.6 | 9.1 to 17.5 | 8.9 to 17.1 | -4.9 to 7.6 |

1/ Treatment 1; normal drying, no lint cleaning.
Treatment 2; normal drying, two lint cleanings.
Treatment 3; extra drying, two lint cleanings.
Treatment 4; no drying, two lint cleanings.

2/ Ends-down per thousand spindle hours.

3/ The confidence intervals indicate that in 95 percent of the cases, the intervals obtained from this experimental procedure and analysis would include the true mean difference.

be significantly higher for that cotton from which the largest proportion of moisture has been removed. Even within the narrow ranges of this study, the use of no heat produced final lint moistures almost identical with normal drying. But short fiber content in the cotton to which heat had been applied artificially in the ginning process was higher.

## Economic Implications

Spinning end-breakage is only one of the factors which may be affected adversely by production or ginning practices. There is generally a direct relationship between spinning and weaving; both of which may affect direct labor costs in manufacturing. If management decides to decrease operating speeds because of inferior spinning and weaving qualities, this decrease in output increases cost. Moreover, the cost of changing speeds, together with decreased production makes employing additional labor sometimes the cheapest alternative. This, in turn, may present a problem because labor is not always freely available in the quantities required on an intermittent basis.

Cotton which does not perform well in spinning and weaving does not produce the highest quality cloth. Adverse effects on the quality and value of the cloth constitute a third source of loss resulting from deterioration in the quality of cotton. Also, decline in the quality of cotton products may cause permanent losses of market outlets to competing products.

Clearly evident in the areas of both cotton production and marketing is the necessity for establishing means of properly identifying, measuring, and evaluating those properties that contribute to cotton's capabilities. These properties must be measured by their effect on manufacturing performance and value of the finished products. In the marketing system, adequate standards are needed to reflect these differences at least fairly accurately if desirable spinning properties are to be placed in cotton and preserved through the several stages of production, marketing, and manufacturing. Technological progress in these areas is dependent upon the combined efforts of all concerned in making available increasingly better products to the consumer at reasonable prices.

Appendix A - Machinery settings for Agricultural Marketing Service pilot plant equipment

## Picker settings:

Beaters:
- Back - 3 blades - 1,180 r. p. m.
- Front - Kirschner - 1,075 r. p. m.

Fans:
- Back - 1,606 r. p. m.
- Front - 1,218 r. p. m.

Feed rolls:
- Back - 2 1/2" Diameter, 7.5 r. p. m.
- Front - 3" Diameter, 8 r. p. m.

Beats per inch:
- Blade beater - 60 beats per inch at 7.5 r. p. m. of feed roll
- Kirschner beater - 28.5 beats per inch at 8 r. p. m. of feed roll

Lap:
- Weight - 14.0 oz. per yd.
- Length - 46 yd.
- Weight (of lap) - 40 lb.

## Card:

Speeds and other data:
- Speed of cylinder - 170 r. p. m.
- Speed of licker-in - 455 r. p. m.
- Speed of flats - 2 1/4" per minute at 100 percent efficiency
- Speed of doffer - 8.5 r. p. m.
- Speed of doffer comb pulley - 1,628 r. p. m.
- Grain sliver produced - 50
- Pounds carded - 10.3 lb. per hour gross at 100 percent
- Waste percent - 5.5 percent
- Production constant - .0243
- Draft - 122.5 (14-oz. lap and producing 50-gr. sliver)

| Settings: | Inches |
|---|---|
| Feed plate to licker-in | .010 |
| Mote knife to licker-in (top) | .012 |
| Mote knife to licker-in (bottom) | .010 |
| Licker-in screen (front) | .029 |
| Licker-in screen (back) | .017 |
| Licker-in to cylinder | .007 |
| Flats to cylinder (back, center, and front) | .009 |
| Back plate to cylinder (top) | .029 |
| Back plate to cylinder (bottom) | .034 |
| Front plate to cylinder (top) | .029 |
| Front plate to cylinder (bottom) | .034 |
| Doffer to cylinder | .007 |
| Cylinder screen (back) | .029 |
| Cylinder screen (center) | .034 |
| Cylinder screen (front) | 3/16 |
| Doffer comb to doffer | .022 |
| Flat comb to flats | .017 |

Appendix A - Machinery settings for Agricultural Marketing Service pilot plant equipment, Continued

Settings for drawing:

Bottom roll diameters:
Front - 1-1/8"
Second - 3/4"
Third - 1-3/8"
Fourth - 1-3/8"
Fifth - 1-3/8"

Top roll diameters:
Front - 1-3/8"
Second - 1-7/8"
Third - 1-1/2"
Fourth - 1-1/2"

Top roll weighting:
Front - 80 lb.
Second - 130 lb.
Third - 80 lb.
Fourth - 80 lb.

Roll settings:
Front to third - 2-9/16"
Third to fourth - 1-11/16"
Fourth to back - 1-7/8"

Production in feet per minute - 265

Roving settings: FS-2 roving frame, Shaw drafting principle

Bottom roll diameters:
Front - 1-1/8" - Case hardened
Second - 1" - Case hardened
Third - 1" - Case hardened

Top roll diameters:
Front - 1-5/16"
Second - 1-1/4"
Third - 1-1/2"

Roll settings:
Back to middle - 1-1/2"
Middle to front - 2-1/16"

Spinning frame settings: Tru-set spinning - Duo-Roth control draft. Model SF-3H Model No. 41

Traverse - 9"
Diameter of whirl - 1-1/16"
Diameter of cylinder - 10"
Ratio of cylinder to whirl - 9.22
Ring size - 2"
Flange - No. 1
Gauge - 3 1/2"

Diameter of top rolls - Roll covering - J - 490
Front - 1-1/8" Spring weighted
Middle - 1" Spring weighted
Back - 1-1/8" Spring weighted

Diameter of bottom rolls:
Front - 1"
Middle - 1"
Back - 1"

Appendix B.--Ends-down per thousand spindle hours, by ginning treatment, by replication, and by hour of spinning, ginning-spinning test, Shafter, Calif., season 1958-59

| Hour of spinning | Ginning treatments: 1 Normal drying, no lint cleaning | 2 Normal drying, two lint cleanings | 3 Extra drying, two lint cleanings | 4 No drying, two lint cleanings |
|---|---|---|---|---|
| | | Replication 1 | | |
| 1 | 45 | 25 | 57 | 31 |
| 2 | 24 | 23 | 34 | 28 |
| 3 | 28 | 18 | 22 | 10 |
| 4 | 18 | 18 | 34 | 3 |
| | | Replication 2 | | |
| 1 | 39 | 29 | 42 | 25 |
| 2 | 25 | 28 | 62 | 27 |
| 3 | 19 | 32 | 36 | 39 |
| 4 | 26 | 25 | 42 | 27 |
| | | | | |
| 1 | 29 | 35 | 51 | 48 |
| 2 | 29 | 21 | 45 | 20 |
| 3 | 36 | 21 | 46 | 30 |
| 4 | 23 | 16 | 32 | 22 |
| 5 | 27 | 19 | 19 | 19 |
| 6 | 24 | 14 | 32 | 24 |
| 7 | 23 | 20 | 25 | 13 |
| 8 | 9 | 19 | 24 | 24 |
| | | Replication 3 | | |
| 1 | 64 | 61 | 61 | 28 |
| 2 | 43 | 75 | 53 | 31 |
| 3 | 38 | 60 | 52 | 28 |
| 4 | 42 | 42 | 58 | 30 |
| | | | | |
| 1 | 47 | 59 | 69 | 47 |
| 2 | 38 | 58 | 52 | 21 |
| 3 | 35 | 36 | 53 | 39 |
| 4 | 31 | 47 | 30 | 21 |
| 5 | 27 | 44 | 37 | 15 |
| 6 | 29 | 29 | 37 | 23 |
| 7 | 12 | 35 | 21 | 22 |
| 8 | 23 | 34 | 34 | 27 |
| | | Replication 4 | | |
| 1 | 47 | 23 | 51 | 56 |
| 2 | 28 | 24 | 47 | 52 |
| 3 | 31 | 25 | 46 | 43 |
| 4 | 20 | 17 | 35 | 37 |
| | | | | |
| 1 | 44 | 26 | 44 | 65 |
| 2 | 39 | 23 | 43 | 48 |
| 3 | 41 | 24 | 39 | 45 |
| 4 | 23 | 21 | 41 | 38 |
| 5 | 28 | 24 | 35 | 43 |
| 6 | 27 | 16 | 47 | 40 |
| 7 | 35 | 17 | 33 | 31 |
| 8 | 34 | 12 | 40 | 29 |
| Mean | 31 | 30 | 42 | 31 |



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